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Easy aligned telescope for cubesat

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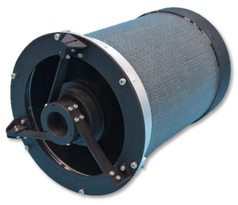
ABSTRACT

Recently there is high demand on earth observation with Cubesat. Usually the researcher only uses general COTS on board camera with Cubesat on its purpose. However, if the researcher needs more resolution or different wavelength, it needs custom designed telescope for it, but telescope needs high accurate optics components and its aligned accuracy.Creating a specially designed optical telescope not only costs enormously, but also takes time from design to manufacture. Furthermore, if the processing accuracy in optical processing and the accuracy in the degree of adjustment in the assembly adjustment stage are ensured, higher-precision design, processing, and assembly adjustment are required.When using Cubesat, considering how to shorten the time from kick-off to launch, a nd considering the short lifetime due to low orbit, it is important to build a system that can acquire fast, cheap, but high-definition images.
In this study, we aimed to achieve higher resolution even with a limited optical element configuration by combining the optical design of the reflection system and the refraction system. Furthermore, by simplifying the assembling adjustment process as much as possible, a low cost and quick manufacturing was sought.

■Background

Crystal optics experiences 35 years precise optical manufacturing. machining, grinding lapping and polishing. Since the beginning of the company, we have focused on enriching our processing machines and measuring instruments.

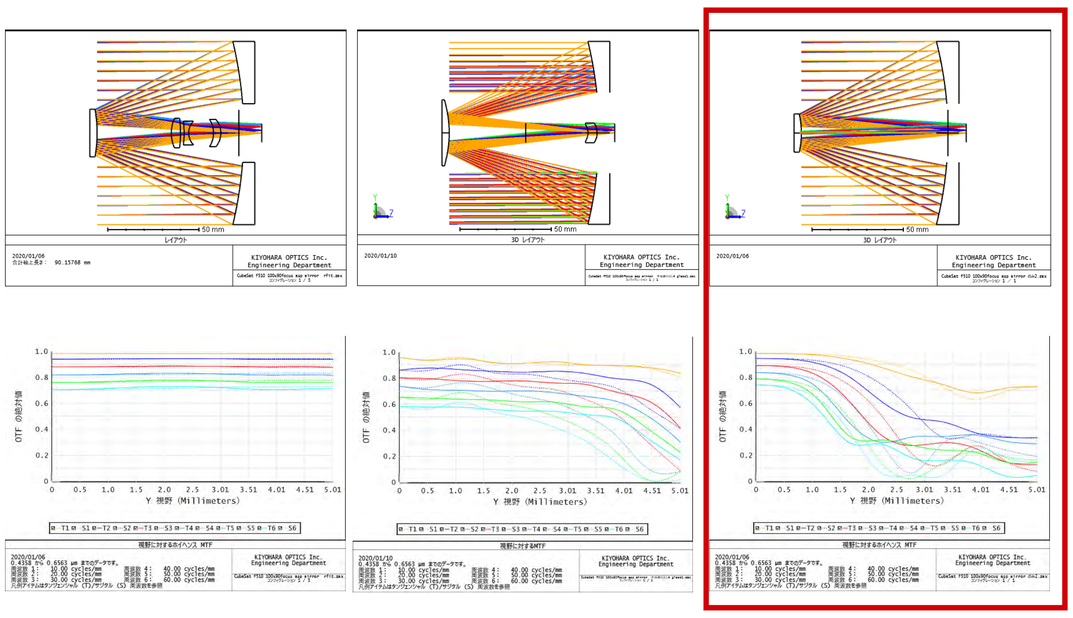
KIYOHARA OPTICS experiences over 70 years on R&D field with National labs, universities and major optics, electric and automotive companies. we've done many R&D projects, not only aerospace industry and the other fields such as astronomy, communications, camera and medical industries. We built Telescope for HODOYOSHI-4 Sat (Universith of Tokyo, NesTRA) in 2016 for EO.

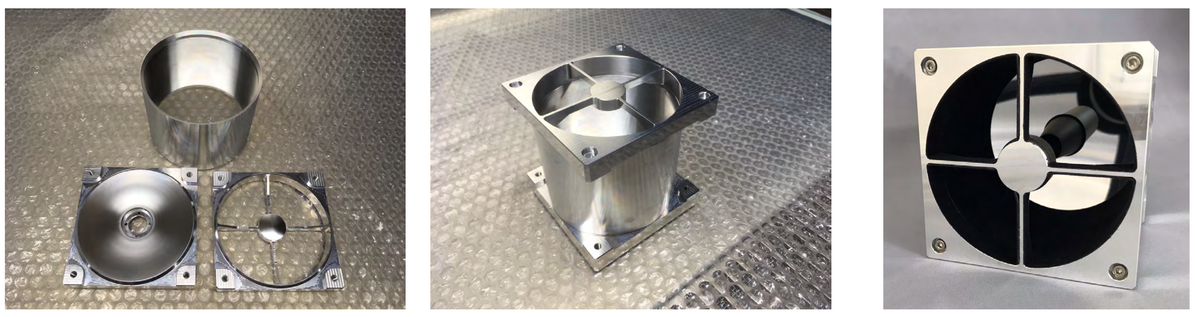


Primary Mirror	Φ150mm
G S D	6m
Weight	3.8kg
F L	1,000mm

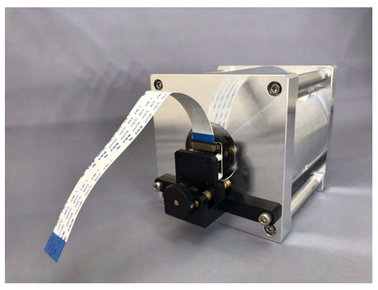
■Method

The basic optical configuration is the Cassegrain method, with the aim of using a primary mirror that maximizes the specified area to secure light quantity more efficiently, and to transmit light to a refraction system that removes aberrations with an optimized secondary mirror.
In a telescope, it is usually required to mount each optical element in a metal frame, and to perform an assembly adjustment to secure the performance as a telescope by an optimal mount in which an optical mechanism is designed. However, by aiming to simplify the assembly adjustment, the most important simplification of the optical axis adjustment was achieved by integrally processing the mounting mechanism and the reflective optical element with aluminum.



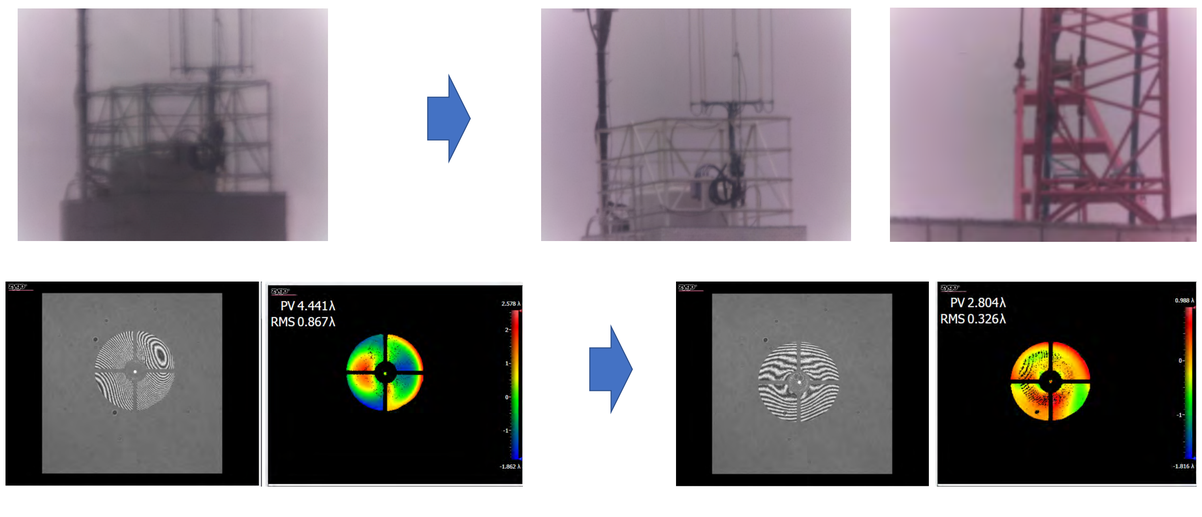


To remove aberrations, some refraction systems were adopted, but the main focus was to minimize the number of components.The simplification of assembly adjustment and the integrated processing of aluminum adopted for the purpose of short-term production of a high-definition telescope contribute to stability in a temperature change.By using the same CTE material for the optical element and its holding member, the expansion due to temperature was compensated, the distance between the surfaces of the optical element was maintained as much as possible, and the stability of the optical path length was improved.
This time, we report on the development of a telescope for cubesat by using the Raspberry Pi for its camera to promote the use of a wider range of research applications.



■Result

We made demo unit for this study with modified optical design for short distance. At first, taking a photography with rough alighment the wave front error was PV 4.4 lamda(on the left).
After realighnment, the error improved to PV2.8 lamda.



■Conclusion and Discussion

In this study, We were able to design and built demo proto unit for easy-alighned telescope for cubesat. However, we could only check the alighment with mechanical configurations. We need to check more thirmal distortion or change formation, moreover vibration circumstaces.
We really appreciate the your opinion and future discussion.